Technical Notes ON BRICK & TILE CONSTRUCTION

VOL. 5 NO. 1 JANUARY 1954

STRUCTURAL CLAY PRODUCTS INSTITUTE

REINFORCED BRICK MASONRY — I

(An Introduction to Reinforced Brick Masonry)

INTRODUCTION

The term "Reinforced Brick Masonry" or "RBM" means simply brick masonry in which steel reinforcement is embedded and so placed that the masonry will have greatly increased resistance to forces which produce tensile, shear and compressive stresses. The principles of RBM design are the same as those employed for reinforced concrete, and any architect or engineer who is experienced in the design of reinforced concrete will have no difficulty in projecting his knowledge and experience to the requirements of RBM.

Likewise, the technique required of the bricklayer in building RBM will be the same as for unreinforced brick masonry, except that it is of even greater importance that all joints be completely filled and that strong bond is developed between brick and mortar. The method recommended for accomplishing this is to fill all interior joints with grout which is merely mortar to which sufficient water has been added to give it a fluid consistency. (Fig. 1).

This type of construction is commonly called "reinforced grouted brick masonry." However, since it is recommended that all reinforced brick masonry be grouted and, in fact, all modern building codes containing requirements for reinforced masonry require it to be grouted, the term "RBM" as used hereafter will indicate reinforced *grouted* brick masonry.

Fig. 1

HISTORY

RBM was first used some 140 years ago in England by Marc Brunel and later in France and in India. However while reinforcement has been used to strengthen masonry at various times during the past century, in the modern sense reinforced brick masonry is a relatively new type of construction in the United States, requiring new design procedures and construction methods. These have been developed during the past 30 years from experimental investigations and the design and construction of hundreds of buildings which have demonstrated the practicability and economy of the construction and whose performances have confirmed the soundness of the principles of design.

The first recorded organized research on RBM is reported in Technical Paper No. 38 published in 1923 by the Public Works Department of the Government of India. Since 1924, research in the United States on RBM has been carried on widely at practically all of the principal engineering colleges and at the National Bureau of Standards. Therefore, during the past 30 years RBM has progressed to the point where engineers may now design in reinforced brick masonry on a rational basis, and, based on the

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materials used in the construction, can predict strengths from which working stresses can be fixed with reasonable accuracy.

RBM has experienced its greatest use and development in the seismic areas of the Pacific Coast area, where it is one of the recognized and most widely used types of construction designed to resist the lateral forces produced by earthquakes.

ADAPTABILITY

Reinforced brick masonry has been used for a wide variety of structures. In those countries where labor costs are very low, one of its principal uses has been for the construction of floor and roof slabs. In the United States, however, its most extensive use has been in the construction of vertical members such as walls or columns. Since no forms are required for these members, reinforced brick masonry is competitive with reinforced concrete and walls of minimum thickness and light structural members can be constructed at substantially less cost in RBM than in reinforced concrete.

Proof of the adaptability of RBM would be shown by the long list of structures in which that type of construction has been successfully used during the past 30 or more years. Space does not permit their being listed but they include large industrial and commercial buildings (warehouses, power plants, stores and factories), public schools, college and university buildings, hospitals (VA hospital now under construction in Los Angeles, California is one outstanding example), churches, public buildings, residential buildings and such special structures as storage bins (circular or rectangular), highway bridges, bleachers, etc. Even in structures not requiring design against lateral forces, RBM lintels are being used more and more by many architectural and engineering offices. Not only do such lintels cost considerably less than structural steel lintels but, of even more importance, the danger of steel corrosion and subsequent cracking of the masonry is eliminated.

A complete listing of all structures utilizing RBM would show its versatility and its widespread acceptance by engineers and architects.

WALL TYPES

Reinforced brick masonry walls may be bearing walls with or without pilasters, curtain, panel or filler walls, shear walls or partition walls. The examples of wall sections shown in Figs. 2, 3, 4 and 5 are not standards to be used without question, but as merely suggested methods. The details used for any structure will depend upon design conditions and

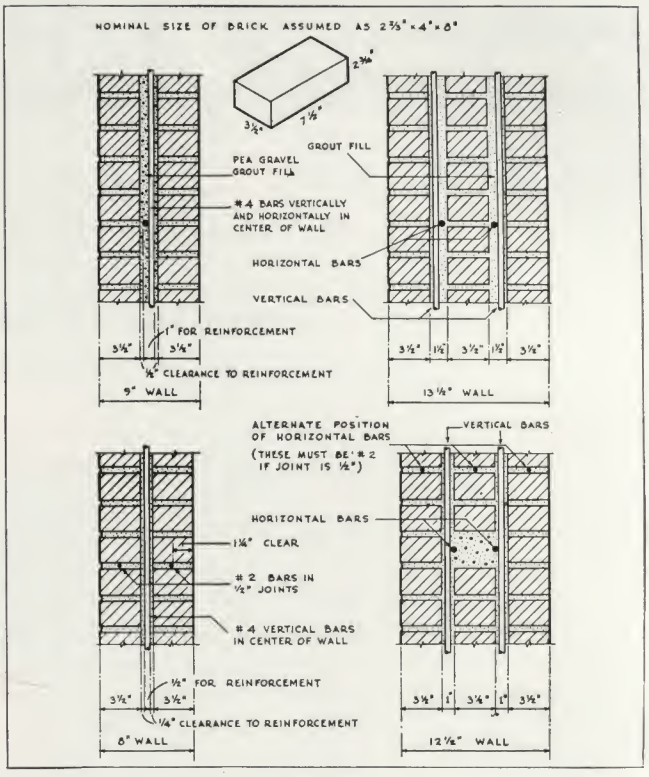

Fig. 2

the type of materials available. The designer, therefore, must use ingenuity.

Fig. 2 illustrates various RBM wall sections and thicknesses constructed with modular brick of conventional size. Variations are possible as brick sizes vary locally. In most cases the variations will be largely in the overall wall thickness when brick of different widths are used. Thickness of vertical or horizontal joints is determined by the size of reinforcing bars used. A minimum of ¼ in. clearance must be maintained between the bars and the masonry units except that No. 2 (¼ in.) bars may be used in ½ in. joints.

In Figs. 3 and 4 are illustrated RBM wall sections in which special "shaped" brick are used. In the wall sections shown in Fig. 3, the use of the so-called "angle" brick permits the vertical steel to be placed closer to the outside wall surface, thus increasing the effective depth. This may also be accomplished by using split or soap brick as shown in Fig. 5. In Fig. 4 are shown typical wall sections constructed with another type of special brick known as "Groutlock" brick. The beveled edges of these units provide more space for both vertical and horizontal reinforcing. Although such special shaped brick as shown in Figs. 3 and 4 have been developed in some areas for RBM, this type of construction can be designed and constructed with the conventional brick shapes and sizes found all over the country.

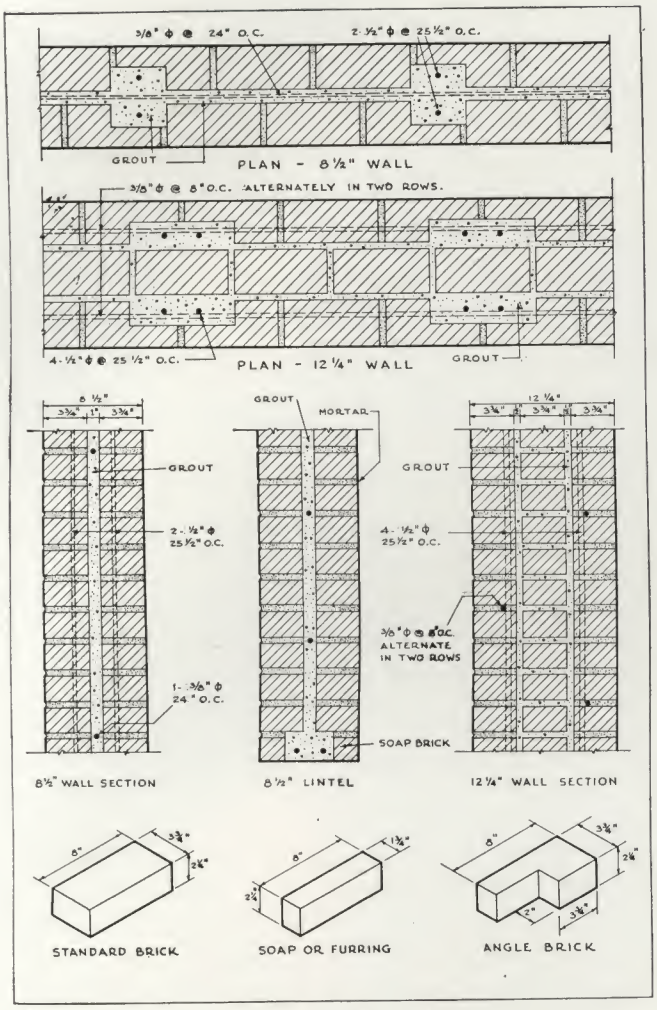

Fig. 3

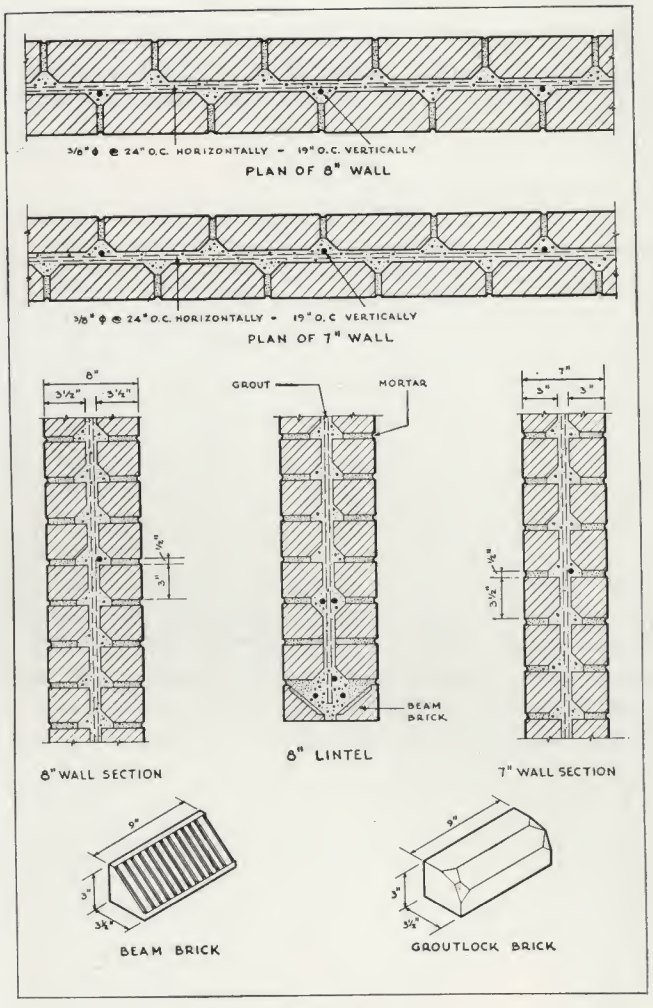

Fig. 4

An RBM wall designed for blast resistance is shown in Fig. 5. As can be seen, this wall is heavily reinforced and split or soap brick are used so that the reinforcing can be placed nearer the outside surfaces.

COSTS

Costs of RBM, as for other types of construction, will vary greatly in different sections of the country. Therefore, absolute costs cannot be given here. However, the following estimates from experienced contractors indicate the relative costs of RBM and reinforced concrete walls.

The costs in Table 1 are for walls with minimum reinforcement (not less than 0.002 times the cross-sectional area of the wall for RBM and 0.0025 times the wall cross-sectional area in both directions for reinforced concrete).

In Table 2 are estimated costs of the RBM wall shown in Fig. 5 and designed for blast resistance in accordance with criteria established by the Veterans Administration for hospital construction in so-called

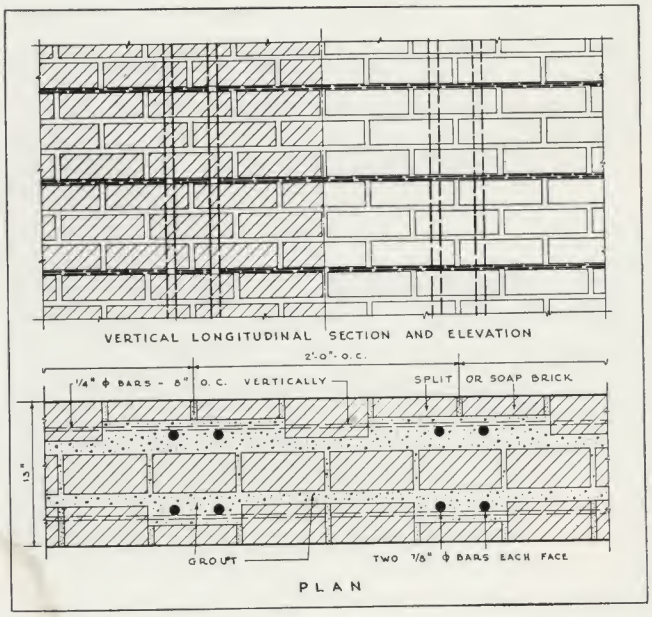

Fig. 5

"target" areas. For the Cleveland, Ohio area in question, these costs are approximately the same as for a reinforced concrete wall of equivalent strength.

TABLE 1

Estimated Cost per Square Foot of Wall Area RBM and Reinforced Concrete Walls

Los Angeles Contractors August 1951	Type of Wall	Nominal Thickness	
		8-in.	12-in.
A [1]	RBM	$1.28	$1.68
	Concrete	1.65	1.90
B [2]	RBM	1.53	2.15
	Concrete	1.85	2.15

[1] Includes labor and materials only.
[2] Includes labor, materials, scaffolding, equipment and compensation, but no profit.

In general, it will be found that RBM walls with minimum reinforcement can be constructed at from 10 to 20 per cent less cost than equivalent reinforced concrete walls while the cost of heavily reinforced brick masonry and concrete walls are approximately the same.

TABLE 2

Estimated Costs per Square Foot of Wall Area
13-in. Blast-Resistant RBM Wall

	VA Estimate November 1952	Cleveland, Ohio, Contractors November, 1952			
		A	B	C	D
Total Materials	$1.168	$1.141	$1.21	$1.21	$1.11
Total Labor	1.804	1.851	2.85	2.14	1.35
Sub-total	2.972	2.992	4.06	3.35	2.46
Profit and Overhead	.5944	.598	.81	.27	.39
Total cost	$3.57	$3.59	$4.87	$3.62	$2.85

CONCLUSION

This Technical Notes issue is the first of a series of bulletins to be prepared on reinforced brick masonry and lateral force design. A most complete and authoritative discussion of this subject is found in the book, *Reinforced Brick Masonry and Lateral Force Design*, by Plummer and Blume, published in November 1953 by Structural Clay Products Institute and available at a cost of $4.95 per copy.